Section of Coal-measures on the Cape Breton Coast.

By J. P. Lesley.

			ft.		
	(a.)	Soft shales with a hard belt at the bottom,	20.0		
		Red and green alternations,	10.0		
		Red,	10.0		
		Green,	2.0		
Red belt, 27 feet,		Red,	1.6		
		Green,	.6		
		Red,	1.6		
		Green,	1.6		
Iron,		Fire-clay with nodules of iron,.	5.0	Mud rocks,	85½
	(b.)	Fire-clay, compact, sandy,	2.0		
		Fire-clay, pure,	5.0		
		Red shale,	2.0		
		Fire-clay,	2 0		
Iron,	(c.)	Iron ore, continuous,	.6		
		Shales,	12.0		
	(d.)	A black streak.			
Iron,		Shales, layers of small nodules of iron,	8.0		
	(d.)	A black streak.			
		Fire-clay,	2.0		
		A black streak.			
		Sandstone cliffs,	8.0		
		Sandy top shales,	6.0	Sand rocks,	23 0
Coal,		Coal, good,	1.0		
		Fire-clay running into sandstone,	6.0		
Coal,		Black slate, genuine,	2.0		
		Fire-clay,	8.0		
	(e.)	Slate cliffs,	40.0		
Coal,		Slate,	1.6	Mud rocks,	58.0
"Hub vein," 8 feet,		Soft coal,	1.6		
	(f.)	Solid coal,	4.0		
		Hard coal,	1.0		
	(g.)	Great sand rock, full of plants,	20.0	Sand rocks,	20 0
Coal,.	(h.)	Cannel coal-bed,	1.6		
		Fire clay,	6.0		
		Cannel coal,	.0½	Mud rocks,	10.0
		Fire-clay,	2.6		

		Sandstone,	2.0	Sand rocks, 25
		Flaggy cliff rock,	6.0	
		Sandy slates, becomes dark banded slate rocks,	11.0	
Coal,	(i.)	Cannel coal,	.1	Mud rocks, 45.0
		Underclay,	3.0	
		Sandy clay,	3.0	
		Shaly clay,	6.0	
		Pure clay and fine yellow slate,	4.0	
		Shale,	.6	
		Blackish clay shales,	8.0	
		Soft clay shales,	2.0	
Iron,		Iron ore, balls, thin plate,	.8	
		Sandy shales,	6.0	
		Soft clay shales,	3.6	
		Dark soft clay cliffs,	1.3	
		Soft shales,	7.0	
		Sandstone shales,	2.0	Sand-mud rocks, 92.0
		Shales, gray,	5.0	
		Blackish shales,	1.0	
		Shales, gray,	6.0	
		Massive, flaky shales,	2.0	
		Sandy, flaky clay,	9.0	
		Shale cliffs, sandy,	11.0	
		Blackish shales,	10.0	
		Sandy shale cliffs,	5.0	
		Sandy shales,	20.0	
		Clay, becoming at bottom sandstone, over which	21.0	
Coal,	(k.)	Seam of coal,	.0½	
		Top slate,	6.0	
		Coal, 2 in. in black slate,	.6	
		Under clay shale,	5.0	
		Blackish soft shales,	4.0	Sand-mud rocks, 69.6
		Gray shales,	2.0	
Iron,		Iron ore, poor, sandy,	.6	
		Gray shales,	4.0	
		Sandstone, flinty,	1.0	
		Fire-clay, compact below,	6.0	

		Sandy shales,	6.0	Sand-mud rocks, 69.6	
		Yellow shales,	6.0		
		Gray, blackish shales,	6.0		
		Gray shales, soft, sandy,	12.0		
	(l.)	Soft shales (local),	5.0		
	(m.)	Sandstone, false bedded shales, soft at bottom,	17.0		
		Clay,	.3		
Coal,	(n.)	Cannel coal,	.1		
		Soft, yellow, concret clay, clay slates,	7.0	Mud rocks,	31.5
		Harder shale,	1.0		
		Gray shales,	2.6		
Iron,		Iron nodules.			
		Gray shales,	4.0		
		Soft, blackish shales,	.2½		
		Sandy shales, foliated,	3.0		
		Top clay,	1.0		
		Gray, blackish shales,	.6		
Coal,		Coal slate ("Cannel"),	.6		
		Hard, sandy shale,	.8		
		Coaly matter,	.½		
		Hard, sandy shales,	3.0		
		Compact fire-clay,	8.0		

These are the lowest rocks seen before coming to the south of Little Glace Bay. A slight break in the section takes place here.

	Soft measures,	10.0	Mud rocks,	16.0
Coal,	Coaly top slate,	.4		
	Coal, bituminous,	.3		
	Sand-rock, variable,	1.0		
	Green clay, including horses of sandrock,	.6		
	Fire-clay,	2.0		
	Compacter clay,	2.0		
	Harder sandy clay, Sandstone ledge,	2.0	Sand rocks,	9.0
	Compact sandstone, with thin flag courses,	7.0		
	Fire-clay shale,	3.0	Mud-sand rocks, 35.6	
	Fire-clay, pencil shale,	4.0		

	(o.)	Shale sandstone,	3.6	Mud-sand rocks,	35.6
		Fire-clay, pencil shale,	6.0		
		Sandy shale,	15.0		
		Crumbling shale,	4.0		
		Sandstone,	8.0	Sand rocks,	43.6
		Blackish shales and fire-clay,	4.0		
		Sandstone, massive,	10.0		
		Sandy fire-clay, thin,	2.0		
		Shaly sandstone, with 6 inch flag courses,	7.6		
		Shales (dark outside),	7.6		
		Sandstones, flaggy,	3.0		
		Gray top shales,	1.6		
Coal,		Black bituminous slates,	.5		
		Cannel coal,	.1		
		Black bituminous slates,	.6		
		Fire-clay shales,	1.0		
		Shaly sandstone,	1.0		
	(p.)	Sandstone,	2.0	Sand rocks,	15.6
		Sandy shale,	11.0		
		Fire-clay,	5.0		
Coal,		"Harbor vein,"	5.0	Mud rocks,	30.6
		Shales, foliated,	8.0		
Iron,		Iron ore, plate breaking into balls,	.3		
Coal,	(q.)	Coal, with a centre streak of jet,	.8		
		Shales, red, green, yellow,	7.6		
		Hard clay sandstone,	2.0		
		Clay shale,	5.0		
Coal,		Coal,	2.0		
		Sandy shales, foliated; then compact; then in half-inch layers,	26.0	Sand rocks,	36.0
		Sandstone, then sandy shales,	10.0		
		Gray shales (blackish),	5.0	Mud rocks,	15 0
		Shaly fireclay,	10.0		
	(r.)	Greenish sandstone,	6.0	Sand rocks,	14.0
		Contorted sandstone,	8.0		
		Fire-clay,	2.0	Mud rocks,	31.0
		Gray, green, harsh shales,	4.0		

		Red and green shales,	5.0	Mud rocks,	31.0
		Very soft gray shales,	20.0		
		Three layers of sand-rock,	6.0	Sand rock,	6.0
Iron,		Soft fire-clay; top slate with nodules,	10.0		
Coal,		Coal,	.½		
		Black slate,	.6		
	(s.)	Fire-clay; thin red, green, and yellow shales; then sandy,	6.0	Mud rocks,	38.6
		Shales, false-bedded,	12.0		
		Ferruginous fire-clay,	2.0		
		Hard, blackish slates,	8.0		
	(t.)	Gray, rough, shaly sandstone and dark shales,	12.0	Sand rocks,	18.0
		Massive sandstone.	6.0		
		Yellow sandstone; soon yellow shales, and then black,	20.0	Sand-mud rocks,	20.0
Iron and lime,	(u.)	Tight blue carbonate,	1.0		
Iron,		Green fire-clay, full of nodules of iron,	4.0		
Coal,		Blackish top slate,	3.0		
		Coal streak.			
		Sandstone nodules,	1.0		
Iron,		Shale, yellow, then green, full of nodules of iron,	10.0		
		Soft fire-clay,	1		
		Shale, yellow; then sandy; then clayey; then fire-clay,	8.0	Mud rocks,	70.6
		Fire-clay, blackish; then gray,	10 0		
Coal,		"Boutellier's vein," (?)	2.0		
		Fire-clay,	2.0		
	(v.)	Fire-clay, with nodules,	4.0		
		Shales, blue,	6.0		
Iron,	(v.)	Fire-clay, full of nodules of iron as large as chestnuts,	3.0		
		Clays, various,	12.0		
		Clay, blue-black,	.6		

Shales, red, yellow, and green,	3.0	Mud rocks,	70.6
Wavy, false-bedded, then layered sandstone,	12.0	Sand-mud rocks,	21.0
becomes more of clay,	4.0		
Fire-clay, blue,	5.0		

Last rocks seen at the north side of Great Glace Bay mouth:

Rocks north of Little Glace Bay, ...	471.0
" south " " "	436.0
Total thickness of rocks in the measured section, . .	907 feet.

Beneath these rocks lie the coals (including clay masses) of the cliffs to the east of the Great Glace Bay bar; which I propose to give at another time, in connection with a survey of the coast line eastward.

A few notes to the above section are needful, as follows:

(a.) These rocks cap the square headland projecting into the Gulf of St. Lawrence between the Burnt Head and Little Glace Bay. They are the highest coal-measure rocks of this basin, and perhaps the highest coal-measures south of Sydney Bay. The cliffs are about forty feet high, and exhibit a remarkable contour, caricaturing the human face in profile, by means of the overhanging ledge of hard sand rock at the bottom of the mass, and about half-way of the height of the cliff. See wood-cut (a).

(b.) The upper part of this clay is crowded with small nodules of iron.

(c.) Ranging for a great distance along the cliffs. Stripping it would yield a large quantity of good ore. The plate varies from 4 to 8 inches.

(d.d.) These streaks are not coal, although they resemble it at a distance.

(e.) These shales vary in compactness, but form essentially a homogeneous mass of finely levigated and foliated sandy mud, the top rock of the great coal.

(f.) Of this, only six feet is good workable coal, on the coast, but it increases westward, and with the omission of eighteen inches poorer top coal, yields from six to seven feet of good body coal.

(g.) This mass of building stone is a rare exhibition for these coal-measures. It forms the long point on which the pier is built. Its thickness could not be exactly determined, because like all the very sandy deposits of the section, it is false-bedded and variable. The great sand-rocks underlie all the productive coal-measures, and are seen around Sydney.

(h.) A coal shale, compactly foliated, highly bituminous, burning well, but with much ash, and crowded with fish-scales and minute shells. It sometimes reads thus: Cannel, 8 inches; Bituminous coal, 8 inches; Clay, 1½ inch; Bituminous coal, 3 inches.

(i.) Here comes in a jet-black slate, growing compact like cannel, but nowhere in the cliff a true coal, but rather a black fire-clay, 1 inch thick with black shales above and below; plenty of fish-scales, but no ferns.

(k.) This becomes solid coal, 6 inches thick.

(l.) Is nipped out at water-level.

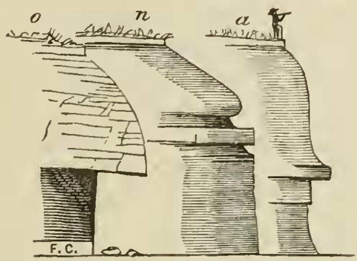
(m.) A great mass of sandstone thrown up at a steep angle not by any general structural movement but by original oblique deposition, has here resisted the wearing action of the waves, and left a curious and instructive promontory.

(n.) Burns well. Plenty of fish-scales.

(o.) The profile of this mass is one of singular architectural beauty.

(p.) Form bold, beetling cliffs over the breakers.

(q.) The centre streak is characteristic, for it appears in the outcrop of the same bed at the New Bridge.



(r.) Local false bedding dips form the point.

(s.) The two lower members are variations seen further south.

(t.) Beautifully false-bedded, scalloped in all directions like the blocks and faces of No. X (Upper Devonian) at the viaduct on the Conemaugh, in Cambria County, Penna.

(u.) Sometimes 1½ feet thick, but will not average more than 10 or 11 inches. It forms a long reef into the sea, in the exact line of the distant headland.

(v. v.) The appearance of these fire-clays, crowded with nodules of iron ore, is very striking; their gnarlly, knobby outcrops form long reefs visible by lines of breakers far out to sea.

The above section was obtained in August, 1862, from the cliffs between Lingan and Great Glace Bays, on the east coast of Cape Breton, from sixteen to twenty miles east of Sydney. Part of it was made out by means of a rope and ladder let down from the upper edge of the cliffs, where these overhung the sea, or occupied intervals between the short sand and gravel beaches. At the upper limit of the section, a square headland projects into the Gulf of St. Lawrence, along the axis of a synclinal basin, with sloping sides of 4° or 5°. From this headland southward, the section was made out by an examination of each layer as it emerged from the sea, past the mouth of Little Glace Bay (where the new harbor is constructing, under the skilful and energetic direction of Captain William P. Parrot, Civil Engineer, of Boston, Mass.) as far as to the mouth of Great Glace Bay.

A similar section might be made, for comparison, starting from the same headland westward, along the cliffs, past Cadougan's Creek, which corresponds to Little Glace Bay, to the mouth of Lingan Bay, which in like manner corresponds to Great Glace Bay. Many interesting variations in the metals would appear from such a comparison. While the general regularity and parallelism is remarkable, there are numerous minor irregularities; some fine instances of false bedding and local deposition; lenticular masses of sand separating adjacent mud-rocks; passages of shales into sandstones, and *vice versa;* gradual coalescing of scattered nodules of clay iron-stone into solid plates, or their gradual pervading of a thick bed of fire-clay, hardening it into so refractory a rock, that its outcrop forms a reef far out to sea. Instances occur of the splitting of coal-beds. The Lingan bed, for example, has, on the sea-shore, a clay parting of half an inch, which, in a quarter of a mile inland, thickens to nine inches; and then, in four hundred yards of gangway continued inland, thickens to nine feet, throwing the upper member of the bed entirely beyond the workings.* In this we have probably the explanation of the difference between the abandoned Bridgeport bed, on the south shore of Lingan Bay, and the Lingan bed on the north shore, separated by a wide and gentle anticlinal; the Bridgeport bed being but 7 feet thick, while the Lingan bed is 9.

A second repetition of the lower half of the section was actually obtained from the cliffs to the eastward of Great Glace Bay; in fact, the section was completed by an examination of the lowest rocks which rise here from the sea.

The section here represented includes the productive coal-measures of Cape Breton, with five workable beds of coal, one of which can hardly be called workable in this area, whatever may be its character in others. In Mr. Brown's section of the North Sydney coal-measures, there are enumerated indeed thirty-four coal-seams; but only four are said to be of workable thickness: Cranberry Head, 3.8 feet; interval (measuring downwards) 280 feet; Lloyd's Cove, 5.0; interval 730 feet; Main Seam, 6.9; interval 450 feet; Indian Cove, 4.8. Mr. Brown's whole section extends to a depth of 1860 feet, or along 5000 yards at a dip of 7° to the N. 60° E.

* The *Cook Vein*, at Broad Top City in Pennsylvania, has a sandrock parting two feet thick, between two 2 foot beds of coal. At the present heading of the long drift, this rock, after first disappearing, leaving the bed of coal 6 feet thick, has increased to 10 feet of tough rock, between two 6 inch beds of coal. This increase of ten feet takes place without crush in a distance of only three to four yards.

Mr. Brown "concludes from the best information in his possession that the *productive* coal-measures exceed 10,000 feet," but I saw nothing in Cape Breton to justify the supposition. He grants that, "owing to several extensive dislocations, it is impossible to ascertain their total thickness with any degree of accuracy." I can only suggest, with deference to his long experience and acknowledged skill, that the structure of the east coast of Cape Breton has not been regarded from a right point of view, inasmuch as the coal-beds have been always represented as members of one basin, dipping broadside into the waters of the gulf; whereas, in fact, along that coast, they occur with alternate northeast and southeast dips, forming a series of basin-ends, the bodies of which lie side by side submerged beneath the gulf. The same four or five workable beds inclosed in the same one or two thousand feet of *productive* measures, appear on shore at the west end of each of these basins. As the dip is commonly gentle, viz., from 4° to 8°, the basins sometimes coalesce; but in one instance at least, that of Cow Bay, the *south* dips are 45°, and the basin is sharp and narrow, greatly resembling the end of one of the anthracite basins of Pennsylvania. As at Sydney, and again at Glace Bay, so here at Cow Bay there are but four workable coal-beds in about 1500 feet of *productive* measures, and they are, no doubt, the Glace Bay beds.*

Sir William Logan, Sir Charles Lyell, Prof. Dawson, and other geologists who have described the coal-measures of Nova Scotia and New Brunswick, agree in assigning to them an almost incredible thickness. "The entire section of the Joggins," writes Sir William Logan, "contains 76 beds of coal and 90 distinct stigmaria underclays," with "24 bituminous limestones," in "a vertical thickness of 14,570 feet."

When we analyze the eight divisions into which this immense mass has been distinguished, we find them thus constituted:

Nos. 1, 2. Sandstones and shales; drift-trees and erect calamites, ...	2267 feet.
No. 3. Sandstones; coal shales; underclays; 22 coal-beds,	2134 "
No. 4. Sandstones and shales, gray; bituminous limestones; 45 coal-beds; shells and fish-scales, ...	2539 "

* The combined thickness of the Lower, Middle, and Upper Coal-measures, as determined by Mr. Jukes, in South Staffordshire, England, is 1810 feet. The thickness of the productive coal-measures of Leicestershire does not exceed 2500 feet. In most parts of the deep Anthracite basins 2000 feet would be a fair average. In Western Virginia and Pennsylvania, and in the deepest parts of the Mississippi Valley areas, 1500 feet.

No. 5. Sandstones and shales, red; carbonized plants, .	2082 feet.
No. 6. Sandstones, $\frac{2}{3}$; shales; bituminous limestone; 9 coal-beds; shells and fish-scales, ...	3240 "
Nos. 7, 8. Sandstones, conglomerates, shales, nod. limestones, two beds of gypsum; remains of plants, .	2308 "
Interval, ...	300 "
Massive limestone with Prod. Lyelli and other Lower Carboniferous fossils.	

It is very evident that the Sydney, Glace Bay, or Cow Bay section of less than 2000 feet of productive coal-measures, can represent but barely one of these divisions, and that it must be either No. 3, or No. 4, or No. 6. Sir William Logan adds, in his resumé, that "Nos. 3, 4, 5, and 6,* contain the equivalents of the productive coal-measures of Pictou and Sydney, and in part of the sandstones which separate them from the Lower Carboniferous series." Prof. Dawson describes minutely his own section of "2819 feet of the central part of the Coal Formation,"† in approaching which, after describing the lower parts,‡ he says: "We have now, after passing over beds amounting altogether to the enormous thickness of 7636 feet, reached the commencement of the true coal-measures."§ By the *true coal-measures* he means, therefore, Division No. 4 and the lower part of Division No. 3, embracing less than 3000 feet of measures and containing but four coal-beds which can be called workable, the rest being from one inch to eighteen inches thick. In descending order we have:

Nine small seams in a thickness of measures of . .	536 feet.	
Main coal seam, 3.6; parting, 1.6; coal, 1.6, . . .		5.
Three minute seams in an interval of	75 feet.	
Coal, .3; clay, .5; Queen's vein, 1.9; shale, 4.4; coal, 1.0,		3.
Ten small seams (largest 1.2) in an interval of . .	762 feet.	
Coal, with three clay partings, ...		$2\frac{3}{4}$.
Three small seams in an interval of	206 feet.	
Coal, ...		5.
Three small seams in an interval of	17 feet.	
Coal, ...		4.
Interval of	32 feet.	
Coal and bituminous shale, ...		5.
Eleven small seams in an interval of	1153 feet.	

The aspect of this section resembles those on the east coast of Cape Breton, where modiolæ and fish-scales are also abundant.

* Dawson's Acadia, p. 178. † P. 177. ‡ P. 127.

§ Described in Proc. Geol. Soc. X, pp. 1–42.

The Albert or Pictou section is said also to contain but five or six seams of coal, two of which are of unusual thickness, as follows: From the surface, down the Success Pit, 73 feet; Main Coal, 39.11 feet thick; Interval, 157 feet; Deep Seam, 24.9. Both these coal-beds, however, are far from presenting solid faces of coal. On the contrary, they are built up, like the 30 and 60 foot coal-beds of the Anthracite region of Pennsylvania, of many layers separated by underminings. The peculiarity here is that these separations are plates of ironstone, not more than six inches thick, instead of being layers of fire-clay, coal-slate, or sandstone. The structure is certainly peculiar, and evinces quietness of deposit and long-continued stability of sea-level, unless we prefer to consider the Pictou area as an upland swamp, unaffected by certain changes of relative land and sea level then going on and affecting the swamps of the coal era around and below it.

But inasmuch as the 60 foot coal at Mauch Chunk, on the Lehigh, is identifiable with the Low Main or Mammoth bed of the Pottsville Basin to the west, and of the Beaver Meadow, Hazleton, Buck Mountain, and Wyoming Basins to the north of it, and through them with still smaller and separated beds further off in the Mahanoy and Shamokin Basins, and even with the bituminous basins of the Alleghany Mountains,—there can be no reasonable doubt, *a priori*, that the 25 and 40 foot beds of Pictou are identifiable with 5 and 6 foot beds of New Brunswick on the one side, and with the 8 and 9 foot beds of Sydney on the other.* The palæontological unity of the Low Main coal of the Pittsburg region with the Low Main coal of Eastern Pennsylvania admits of no doubt. The structural evidence is coincident and precise. Yet, wider intervals of Devonian and Silurian denudation are to be bridged by the theoretical connection

* To illustrate in a still more striking manner this separation of a large bed into several smaller ones, one has only to examine Mr. Jukes's description of the Thick Coal of Dudley, in England, "which, forming at that place *one* solid seam ten yards in thickness, becomes split up into *nine* distinct seams by the intercalation of 420 feet of strata over the northern area of the coal-field." The Main Coal of the Warwickshire area is split up, according to Mr. Howell, into *five* beds by 120 feet of intervening strata. The Main Coal of Moira is noticed by Mr. Hull as a third instance. (See Hull's Paper on the Carboniferous Strata of England, Vol. XVIII, No. 70, Quar. Jour. Geol. Soc. p. 139.) Mr. Lesquereux, in his Report on the East Kentucky Coal-Field, in the fourth volume of Owen's State Reports, p. 360, gives what he considers sufficient evidence of a similar breaking up of the Low Main Coal of the Pittsburg area into three. This is precisely the normal number of large beds into which the great Mauch Chunk or Mammoth Bed separates throughout the Pottsville-Tamaqua Basin.

there, than are called for between the coal areas of the British Provinces. The general bordering of the sea-coast with coal-beds, and the long and parallel stretches of Carboniferous rocks through the interior, are all cogent arguments for continuity of the original coal areas, and therefore for the contemporaneity of the remaining portions of the coal-beds. As the same coal-beds which now cap the highest mountains of the Alleghanies in Northern Pennsylvania, and have been swept away over wide intervals of Devonian valleys between them, descend also into the depths beneath the beds of the lowest valleys drained by the Swatara, the Schuylkill, the Lehigh, and the Susquehanna North Branch, so I have no doubt the coal-beds, whose edges we now see only along the sea-shore of Nova Scotia, or on the sides of the interior low lands, did once ride over the tops of its metamorphic Devonian mountains, whose summits, crowned with cliffs, opposing anticlinal and synclinal dips, remind the Pennsylvanian geologist, at every view he takes of them, of those mountains on which the coal still lies in fragmentary patches in his native State.

What, then, are the thousands of feet of rocks included in Divisions Nos. 5, 6, 7, and 8, of Logan's great section? In other words, the 7630 feet over which Dawson climbed to reach the bottom of his "true coal-measures?"

What, I ask in reply, are those wide stretches of low, rolling, arable country, with a red shale soil, which the traveller sees spreading around all the productive coal areas of Cape Breton and Nova Scotia, especially the latter? To the geologist from the West they afford familiar scenery. He can hardly persuade himself, sometimes, that he is not riding through Lykens or Locust or Catawissa or Trough Creek Valleys in Pennsylvania, over the chocolate-colored soils of No. XI. This formation, 5000 feet thick around the southern Anthracite coal-fields, becomes, indeed, thinner and thinner northwestward, until it is but 500 in the Alleghany Mountains, and not more than 50 beneath Pittsburg. But along its thickest line it extends from Alabama to New Jersey, a good thousand miles. It is not surprising, then, to see it stretching still another thousand miles further in the same direction, and spreading undiminished around the coal areas of Nova Scotia.

Division No. 5 of Logan's section, consists of red shales and sandstones chiefly, 2012 feet thick. There is no reason why this should not be the representative of Formation No. XI, or of its upper part.

If it be objected that Division No. 6 is in fact a coal system with nine beds of coal and numerous bituminous limestones, the objection becomes an additional argument for the identification. For we see in this No. 6 the reproduction, at this immense distance, of the Lower or False Coal-measures of Virginia, where a *productive* coal system underlies the chocolate shales of Formation No. XI, and not only reappears, with workable beds, in Eastern Kentucky and Middle Tennessee, but projects itself, in a recognizable shape, through Western Indiana nearly to Chicago, and through Middle Pennsylvania nearly to the Delaware River. In fact, Lesquereux pronounces the whole coal of Arkansas to belong to this lower system. It may, therefore, very well be found in force in Nova Scotia. Throughout Division No. 6 no bed of respectable size is mentioned. It is an early and imperfect system.

The chief objections to this hypothesis above sustained, will come, 1, from the absence of any general representative for the Millstone Grit or Great Basal Conglomerate of the True Coal-measures; 2, from the sub-position of Divisions 7 and 8, 2308 feet of sands, pebble-rocks, and limestones; and 3, from the presence at a still lower depth of what seems to be the genuine, massive, subcarboniferous limestone. To break the full force of these objections, I can only remark, 1, that the Pictou coal-basin *has* a massive Conglomerate under its productive coal-measures, while elsewhere no one Formation of the whole Palæozoic System is so variable and unreliable and unidentifiable as Formation XII, the Great Conglomerate, technically so called; 2, that Nos. 7 and 8 may be identified with Formation X; and 3, that the subcarboniferous or Archimedes Limestones of the Western United States not only have been subdivided into five separate formations in the Valley of the Mississippi, but wholly thin away and disappear before crossing the Schuylkill and Lehigh Rivers on their way to Nova Scotia. Therefore, although the False or Lower Coal-measures of Virginia and Southwestern Pennsylvania are *overlaid* by limestones with subcarboniferous fossils, the connection, *as to limestone*, is entirely cut away between them and the Nova Scotia deposits, so that the massive gypseous limestones of Nova Scotia may be at any assignable lower level. This argument is rendered all the more forcible by the fact that gypsum is unknown in the United States, except in one or two anomalous positions, apparently connected with the Lower Silurian Limestones, and in the closed basin of Michigan.

Beneath the red shale Formation No. XI, we have, in the southeastern ranges of the Appalachians, nearly three miles' thickness of sedimentary deposits, separable everywhere into three great Formations: No. X, white sandstone, 2000 feet, No. IX, red sandstone, 5000 feet, No. VIII, green and olive shale, 8000 feet; the white sandstone including rarely a thin bed of conglomerate here and there, and traces of coal-plants and even thin coal-beds; the red sandstone passing downwards into red shale, and often alternating flinty sand-rock with massive mud-rocks even in the upper part; and the olive shale becoming near the base of it rocky, and even mountainous in the region of the Juniata, where a system of thin coal-beds was also developed in the midst of the sandstone and shale. The white sandstone of No. X becomes in the Alleghany Mountain belt less than 800 feet thick, and is there characterized by thin-bedded and very irregularly cross-bedded sandstones of a peculiar greenish tint and harsh, rough fracture, weathering to a surface sprinkled with small red dots of peroxide of iron.

It is not too much to say that a geologist well accustomed to these formations, along their great Appalachian belts of mountain and valley, stretching from the Appalachicola and Alabama Rivers in the South, to the Delaware and Hudson in the North, cannot fail to recognize them and distinguish them anywhere. The *tout ensemble* or *facies* of each is *sui generis*. Fossils may come in afterwards as a satisfactory confirmation; but the eye has already determined the respective formations. Even in the West, where Formation IX has dwindled, like Formation XI, to an insignificant one or two hundred feet, and scarcely separates the green sands of X from the green shales of VIII, the characteristic features of the three formations, although modified and harmonized by the preponderance of the argillaceous element, are still in sufficient contrast to be recognized when fairly seen.

To an eye thus trained among the broad outcrops of the Lower, Middle, and Upper Devonian of the Appalachians, it is evident that the mountains of Cape Breton and the hills of Northern Nova Scotia, surrounding or intervening between the already-mentioned red shale borders of the coal areas, are composed of these formations. True, the anticipation of finding these formations has a tendency to warp the judgment and delude the eye, especially when that anticipation is based upon such a probability as this: that a massif, three miles thick and a thousand miles long, will maintain its thickness (and of course its topographical height and geographical breadth) at least as far along the prolongation of its isometric axis (to use Mr. Hull's new and much-needed term), as will such minor formations as the Coal over it or the Upper Silurian limestones under it. In other words, if analogies between the Nova Scotia and the United States coals compel us to consider them synchronic, if not originally conterminous; and if the Clinton fossils of New York, and even the Dyestone* iron ore of Pennsylvania, Tennessee, and Wisconsin, be found at Arisaig, and along a well-defined outcrop in the direction of Truro; surely the Second Mountain, Little Mountain, Orwigsburg Mountain, and Summer Hill, upon the Schuylkill River, must be represented by the Antigonish Mountains of Nova Scotia, and by the Sydney and St. Peter's Range in Cape Breton: and this, whether the Nova Scotia carboniferous rocks or subcarboniferous limestones be deposited upon the Devonian conformably or unconformably. The Province is in fact a wide belt of mountains partially submerged; and may have been to some extent in the same condition at the beginning of the Coal era. In the Antigonish Hills we may have principally Formation VIII, while in the country south of the Lake Bras d'Or we may have the full series of VIII, IX, and X. The Arisaig formation, with fossils once thought by Hall and Lyell to be Hamilton and Chemung, and now considered by Hall and Dawson to be indisputably Clinton, although overlaid and concealed along most of its extent by apparently nonconformable coal-measures, gives us a fixed lower limit for the so-called metamorphic hill country of the Province, which makes this hill country necessarily Devonian, or Formations VIII, IX, and X. Even if we object to the term Devonian, and permit the palæontologists to carry down the term Carboniferous, or the term Subcarboniferous, step by step, so as to include first, Formation X, perhaps rightly, and then the genuine Old Red IX, and even, as the effort is in the Western States, to include Formation VIII down to its black shale beds with coal, the change of term will not change the lithology,—the mountains of Nova Scotia must still be the representatives of the Catskill, Mohantongo, Terrace, and Alleghany Mountains of New York and Pennsylvania.

The eye can hardly be mistaken in the features of the roadside banks between Antigonish and Merigonish; the road defiles through hills of VIII. Equally certain is it that the outcrops on the road from St. Peter's to Sydney are of the reddish and greenish sand rocks of IX and X. The road for forty miles winds along the lake shore, and in and out of ravines descending from a group of parallel mountains of these formations, made parallel by a system of parallel anti-

* Described by Dawson, p. 58, supplementary chapter to Acadian Geology, August, 1860.

clinal and synclinal curves which issue from the lake and throw the mountain dips to the north and to the south alternately, at angles from 5° to 45°. Great rib-plates of flinty sand rock rise to the summits and form tablets with broken cliffs upon the outcrop side, fine objects seen thus against the sky. The mountains at the head of the east arm of the lake, and those on its northern side forming the peninsula, come down upon the shore in the same style, and belong to the same system. On the south side of Miré Bay, in the ravines east of the Gabarus road bridge, there is no mistaking the aspect of masses of slates of No. VIII standing at 45°; nor can one be convinced that he is not riding through a forest grown on a soil of IX, as he is whirled over the fine old road from Miré bridge to Louisburg, although the highest elevation of the plateau is but 350 feet.

Whatever impression the Devonian and subcarboniferous sediments of Nova Scotia and Cape Breton may make upon a geologist from the Middle States, certainly his wonder will be piqued by striking analogies between the exhibitions of the workable coal-measures at two such distant places as Sydney and Pittsburg. The resemblance is more than general; it has special points.

At Pittsburg there are about a thousand feet of coal-measures (to the top coal), with a great bed 8 or 10 feet thick near the top, a 6 foot bed half way down, two small workable beds in the lower half of the column, and a large bed (4 to 8 feet) at the bottom.

At Sydney (Glace Bay), in like manner, there are about a thousand feet of coal-measures, with an 8 or 9 foot bed towards the top, a 6 foot bed half way down, two smaller beds in the lower half of the column, and a 7 or 8 foot bed near the bottom.

At Pittsburg, as at Glace Bay, the upper 18 inches or 2 foot of the High Main coal is rejected.

At Pittsburg, as at Glace Bay, the middle 6 foot coal (Upper Freeport of the Alleghany River and Cook Vein of Six Mile Run) is famous for its solid face and excellent quality.

No one should admit that such coincidences furnish a demonstration of identity. But it must not be overlooked that the beds of the Pittsburg area have been traced and identified from end to end of areas with a diameter, in all, of over a thousand miles, even across the denuded interval of Central Kentucky. The expectation may, therefore, be pardoned, not as an amiable enthusiasm, but as a logical inference, that when the fossil groups of the individual beds of Cape Breton shall have been thoroughly studied by Lesquereux and other competent botanists, their identification with the beds of the

West may be made somewhat more than possible. The zone of sediment, when taken along its isometric axis, is equal enough over *a priori* incredible distances. Logan and Hunt and Murchison are finding the Quebec group, the Huronian and Laurentian systems in Scotland and Scandinavia, not by fossils, but by aspect. No one doubts the extension of the Millstone Grit and the Mountain Limestone of England to Pennsylvania. Why should the remarkably homogeneous and continuous Flora of any one of the immensely outspread beds of the United States not be homogeneously continuous to Rhode Island, New Brunswick, and Cape Breton?

One remarkable feature, however, in this resemblance of the two coal columns at Pittsburg and Sydney, must not be forgotten. I refer to the mass of red shales which cap the Glace Bay section. A similar deposit occurs, at a fixed horizon, widely spread over Western Pennsylvania, but *beneath*, not *above*, the High Main coal.

Dr. Wood noticed a visit which he and Prof. Henry had made to Dr. Wistar's house, since the meeting of September 19th, to re-examine the lightning rod connections, and they found this case to be no exception to the general rule, that where the connections are perfect, the building is secure. Dr. Bache described the connections of his house-rods at the corner of Spruce and Juniper Streets, with the city gas pipes.

And the Society was adjourned.

Stated Meeting, November 21, 1862.

Present, seventeen members.

Judge SHARSWOOD, Vice-President, in the Chair.

A letter accepting membership was received from T. J. Lee, dated Washington, November 11, 1862.

A letter announcing the decease of M. Edmi-François Jomard, at his residence in Paris, September 23d, 1862, aged 85, was received from his son and other relatives, dated Paris, September 30, 1862.